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ABSTRACT

An evaluation of a new grade of CXM-7, the explosive component of PBXN-109, was conducted at DSTO as R & D support to ADI Ltd, the sub-contractor for the manufacture of the Penguin ASM warhead. Tests were performed to characterise the material's physico-chemical and sensitiveness properties. The processing properties of PBXN-109 incorporating this grade of CXM-7 were also evaluated and the explosive performance properties were determined. Testing showed the new CXM-7 to be contaminated with an unknown material which adversely affected its processing properties. However, it was noted that the new material had a particle morphology more suited to processing than the original CXM-7. The explosive properties of PBXN-109 containing the new CXM-7 were equivalent to the current material. If the new material can be obtained free from contaminants it does offer some advantages, in terms of processing and quality of the explosive fill, over the original CXM-7.

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Executive Summary

The polymer bonded explosive, PBXN-109, is manufactured by Australian Defence Industries Limited (ADI) for use as the explosive fill in the Penguin Anti-Ship Missile warhead in support of Project Sea 1414. The energetic component of PBXN-109 is cyclotrimethylenetrinitramine (RDX) supplied to ADI as a plasticiser desensitised material, known as CXM-7, by Dyno Nobel, Norway. Dyno Nobel offered ADI an alternative grade of CXM-7 that is essentially the same as the original material but reputed to provide superior processing and casting properties. As the casting properties of the current PBXN-109 are marginal such an improvement would result in better quality fills and potentially reduce the risk of rejection (due to size and quantity of voids) of the filled warhead.

DSTO conducted a series of tests to characterise the new CXM-7 and to compare it with the original material. The characterisation tests involved determining a range of physico-chemical and sensitiveness properties that showed the material to be similar to the original CXM-7 apart from the particle morphology. Due to a different processing technique the RDX particles in the new CXM-7 were more rounded than the original material, in which the particles were highly angular and irregular. Further testing was conducted to assess the processing properties of PBXN-109 and its explosive performance properties when containing the new CXM-7. As suggested by Dyno Nobel, and from the observed rounded form of the particles, the new CXM-7 produced a slurry of PBXN-109 with lower viscosity and better flow properties. However, it was also noted that the cure reaction rate of the slurry was much greater than the original material thus rapidly negating the initial lower viscosity and superior flow properties. This was subsequently determined to be due to a contaminant contained in the CXM-7. The explosive properties (velocity of detonation, detonation pressure and shock sensitivity) were found to be identical to the original material.

Communication with Dyno Nobel confirmed the presence of a contaminant in the batch of new CXM-7 supplied to DSTO. Dyno Nobel have identified its source and undertaken measures to prevent its re-occurrence. In its present form the new CXM-7 is unsuitable for the manufacture of PBXN-109 to be used in the Penguin warhead. However, if the contaminant is removed and the product exhibits a desirable cure reaction rate there are benefits (improved quality, lower rejection, cost savings) from using the new material in the PBXN-109 explosive warhead fill.

Contents

Abbreviations

ADI	ADI Limited
AO	Anti-oxidant
ASM	Anti-ship missile
BAM	Bundesanstalt für Materialprüfung
CXM-7	RDX coated with plasticiser (DOA)
DOA	Dioctyl adipate
ESD	Electrostatic spark discharge
FFI	Forsvarets Forskningsinstitutt (Norwegian Defence Research Establishment)
F of I	Figure of insensitiveness
HMX	Cyclotetramethylentetranitramine
HTPB	Hydroxyl terminated polybutadiene
IM	Insensitive munitions
IPDI	Isophorne diisocyante
IR	Infra-red
JANNAF	Joint Army Navy NASA Air Force
LSGT	Large Scale Gap Test
MRL	Materials Research Laboratory (DSTO)
NMR	Nuclear Magnetic Resonance
PBX	Polymer bonded explosive
PBXN	PBX formulation qualified for in-service use by the US Navy
P_{CJ}	Chapman-Jouguet pressure (Detonation pressure)
RDX	Cyclotrimethylenetrinitramine
SEM	Scanning electron microscopy
T of I	Temperature of ignition
TNT	2,4,6-Trinitrotoluene
TPB	Triphenyl bismuth
VOD	Velocity of Detonation
VTS	Vacuum thermal stability

1. Introduction

The polymer bonded explosive, PBXN-109, is manufactured by Australian Defence Industries Limited (ADI) for use as the explosive fill in the Penguin Anti-Ship Missile warhead in support of Project Sea 1414. The formulation contains, as its explosive component, 64% cyclotrimethylenetrinitramine (RDX), which is obtained as a plasticiser desensitised material from Dyno Nobel Defence Products, Norway. The desensitised RDX, known as CXM-7, is a bimodal blend of RDX of two different mean particle sizes combined to impart suitable processing and casting properties to the explosive slurry to ensure high quality, void-free warhead fills. During the initial manufacturing trials ADI observed that the casting quality of PBXN-109 was marginal and difficulty was experienced in producing void-free castings. The cause of the variability and high end of mix viscosity was attributed to variation in the batch-to-batch content of the plasticiser coating on the RDX and to morphology and particle size distribution of the RDX in the CXM-7.

ADI conveyed these concerns to Dyno Nobel who undertook to investigate the problem. Their investigation showed that the variation in plasticiser content was due to its absorption into the plastic packaging bag. Dyno Nobel agreed that the particle size distribution of the RDX and the amount of the fine RDX included in the bimodal blend would have a significant influence on the processing properties of PBXN-109. Dyno Nobel also stated that they would screen their RDX and test it in small scale mixes to determine the most suitable particle size distribution of the Class 1 RDX to yield optimum processing and casting properties.

In-house studies by Dyno Nobel on recrystallisation of the RDX resulted in a modified process that produces particles with a narrower particle distribution and when tested in a PBXN-109 formulation gave much improved flow properties. This material was offered to ADI for use in future PBXN-109 work and a 15 kg sample was provided for evaluation.

ADI requested that Weapons Systems Division, DSTO, in its capacity of providing R & D support and advice to the Penguin warhead program, conduct an evaluation of the sample of modified CXM-7. This work was undertaken and is reported below.

2. Experimental

2.1 CXM-7 Source

15 kg of the modified version of CXM-7 were received from Dyno Nobel Europe, Defence Products, Norway (via ADI Mulwala). The material was designated batch number NS100M000E003 by Dyno Nobel. The original CXM-7 supplied to ADI for PBXN-109 production (batch number NS198H001-001) was used for comparison purposes.

For convenience, throughout this report, the original material will be referred to as CXM-7 while the modified material will be referred to as CXM-7/M1.

The original material was produced to "Material Specification For Explosive Material, Coated, CXM-7", WS26702 Revision E, Naval Surface Weapons Center, White Oak Laboratory, Silver Spring, Maryland 20910, USA. Dyno's product brochure gives the composition of their CXM-7 as 95.25% RDX and 4.75% DOA. It is not known whether the CXM-7/M1 was produced to the same specification, not withstanding the different manufacturing process used to produce the RDX.

Table 1. Composition of CXM-7 [WS26702[1]]

Component	Weight (%)
Di-(2-ethyl-hexyl) adipate, DOA	4.0 to 5.5
RDX, Type II, Class 1 plus RDX, Type II, Class 5	94.5 to 96.0

The specification WS26702 states "the ratio of RDX, Type II, Class 1, to RDX, Type II, Class 5, shall be 95 to 5 based on input weights". The particle size or granulation requirements for the RDX Classes are defined using U.S. Standard Sieve analysis. MIL-DTL-398D specifies the following for Class 1 and Class 5.

Table 2. Granulation Requirements for RDX Classes [MIL-DTL-398D]

Through U.S. Standard Sieve No.	20	30	100	200	325
Class 1, Wt %	98 ± 2	90 ± 10	60 ± 30	25 ± 20	-
Class 5, Wt %	-	-	-	-	97 min.

The RDX is manufactured by a process that yields Type II RDX and as such may contain from 5 to 12% cyclotetramethylenetetranitramine (HMX) as a by-product. In a minute [1] to ADI, Dyno discusses the changes to the RDX used in CXM-7/M1 brought about by the modified process. The Class 1 RDX undergoes a recrystallisation process to afford RDX with a lower HMX content (<0.5%) and a higher melting point (>200°C). The particle size distribution is reported to be narrower than the standard classes defined by MIL-DTL-398D. Dyno also reports that this version of RDX Class 1 produces mixes with significantly lower viscosity and better flow properties than the original RDX Class 1 material. The Class 5 (fine) RDX does not undergo additional treatment and is nominally identical for both CXM-7 and the modified version.

1 WS 26702, Material Specification for Explosive Material, Coated, CXM-7.

It should be noted that initial inspection of the CXM-7/M1 on receipt at DSTO revealed a distinct difference in odour to the previously supplied material. The reason for this odour was not initially identified. More information on this topic was received as a result of communication with Dyno Nobel and is reported in Section 2.3.4.

2.2 Material Analysis

2.2.1 Plasticiser Content

Washing with hexane isolated the plasticiser coating on the CXM-7 and CXM-7/M1 samples, taken from various locations within the bulk sample. The percentage of plasticiser coating was then calculated as the loss in sample weight. The solvent was then evaporated off and the residue was identified by infra-red (IR) [2] and nuclear magnetic resonance (NMR) spectroscopy as dioctyl adipate. From the weight loss measured it was determined that the plasticiser coating constituted approximately 5% of the sample's mass thus conforming with the CXM-7 specification.

2.2.2 NMR Spectroscopy

^{13}C and ^{1}H NMR spectroscopy was conducted on both grades and the results compared to those obtained from known samples. Both the grades were analysed for RDX while the CXM-7/M1 was also analysed for DOA and HMX. The analysis of the CXM-7/M1 revealed approximately 5% (by weight) percent HMX in the material. This was initially thought to be higher than specified (<0.5%) but correspondence with Dyno (see Section 2.3.4) established this to be the correct amount (additional HMX had been added). The coating was identified as DOA but the amount was not quantified. No impurities were identified using NMR spectroscopy.

2.2.3 Particle Size Analysis

The particle size distributions for the two grades of CXM-7 were measured using a Malvern Mastersizer 2000 particle sizer with the sample dispersed in chloroform. The average particle sizes from 5 runs for each material are presented in Table 3.

Table 3. Particle Size Data for CXM-7

	Particle Size Distribution, µm			
	d(0.1)	**d(0.5)**	**d(0.9)**	**Span**
CXM-7	67	209	424	1.7
CXM-7/M1	105	201	346	1.2

The data in Table 3 and the particle size distribution curves (Figs. 1 and 2) show that the original CXM-7 has a larger mean particle size than CXM-7/M1 and a broader particle size distribution as evidenced by the larger span [(d(0.9)-d(0.1))/d(0.5)]. The

broader particle size range (larger span) for CXM-7 was expected for a milled product. The broad shoulder to the left of the main peak in Figure 1 is consistent with a milled product. The tail of that shoulder, as well as the separate small peak apparent in Figure 2, are a consequence of the added 5% Class 5 RDX.

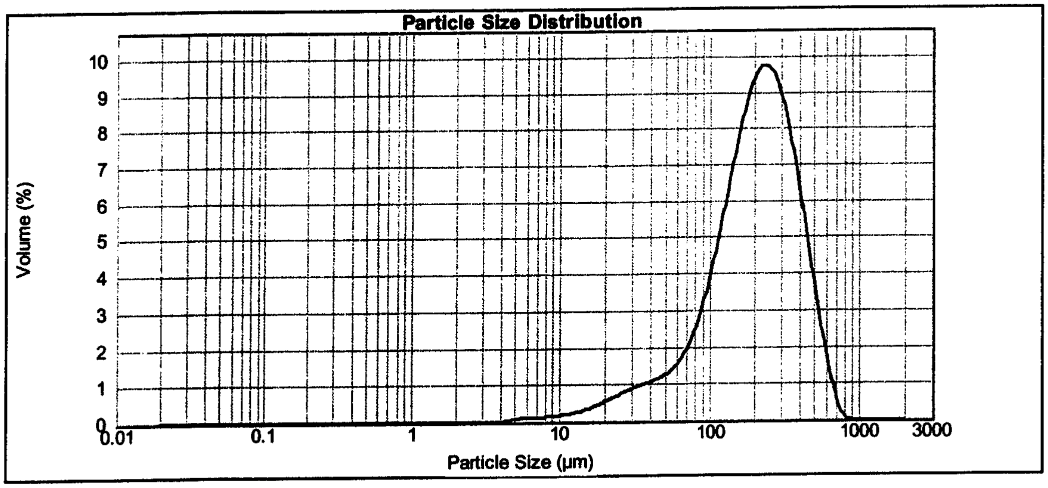

Figure 1. Particle Size Distribution for CXM-7

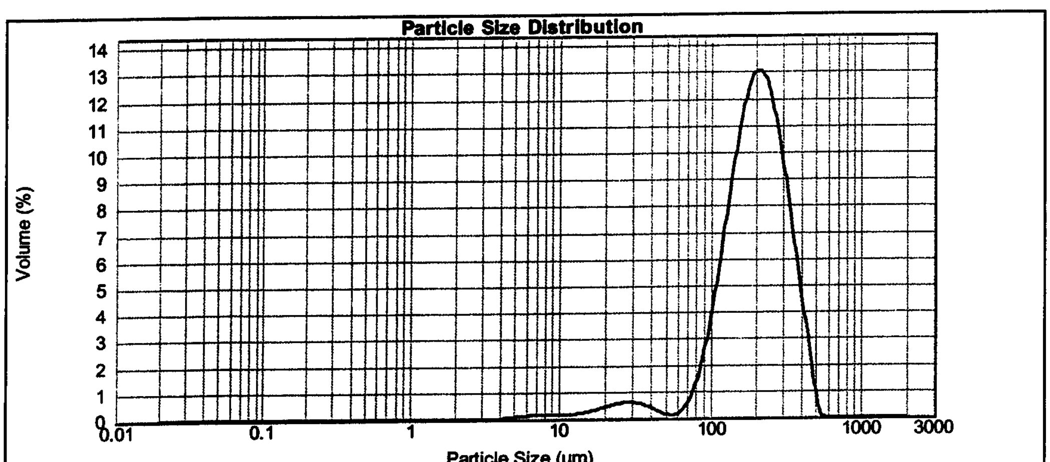

Figure 2. Particle Size Distribution for CXM-7/M1

2.2.4 Scanning Electron Microscopy (SEM)

The original sample of CXM-7 consists of large, angular shaped, planar particles (Fig. 3). The particle size was visually determined in the SEM to range from approximately 200 microns down to smaller than 10 micron in diameter. There was

some evidence of fracturing as shown by clean edges on some particles that is consistent with a milling process.

The sample of CXM-7/M1 consists of individual, spherically shaped, particles with some agglomerations evident (Fig. 4) that is consistent with a recrystallisation process. The sample also showed a similar particle size distribution to that observed in the original CXM-7.

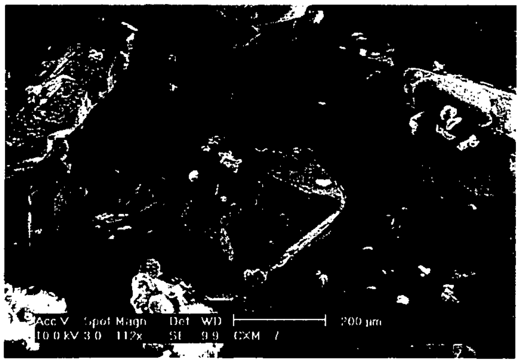

Figure 3. SEM of CXM-7 Particles

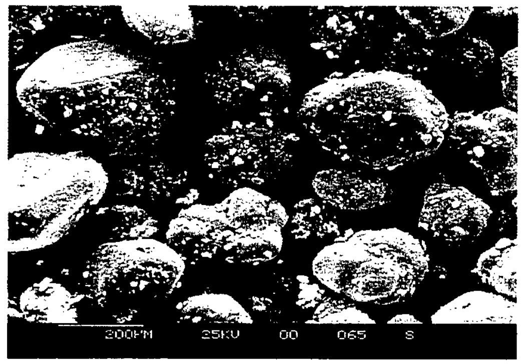

Figure 4. SEM of CXM-7/M1 Particles

2.2.5 Hazard Assessment and Vacuum Thermal Stability

A summary of the hazard assessment [3, 4] and vacuum thermal stability (VTS) testing [5] for the two grades of CXM-7, both with and without the DOA coating, is given in Table 4. The values are shown together with the results obtained for RDX Grade F that was used as the standard. Rotter Impact test evolved gas volumes (mL) are shown in parentheses. The Rotter Impact test is used to determine the Figure of Insensitiveness (F of I).

Table 4. Hazard Assessment and Vacuum Thermal Stability Data for CXM-7 and CXM-7/M1

	CXM-7	**CXM-7 No DOA**	**CXM-7/M1**	**CXM-7/M1 No DOA**	**RDX Standard**
F of I	170 (12.7)	80 (NR)*	160 (9.5)	80 (14.2)	80 (11.9)
BAM Friction (N)	192	108	124	108	120
T of I (°C)	214	213	211	224	223
ESD (J)	Ignition at 4.5 but not at 0.45	Ignition at 4.5 but not at 0.45	Ignition at 4.5 but not at 0.45	Ignition at 4.5 but not at 0.45	Ignition at 4.5 but not at 0.45
VTS (mL/g)	0.08	0.03	0.04	0.08	0.10

* Not recorded

In both versions of CXM-7 the coated samples showed a significant decrease in sensitiveness to impact stimuli when compared with the uncoated samples. Both uncoated samples showed responses similar to those of the standard energetic material

RDX Grade F. CXM-7/M1 shows greater sensitiveness to friction stimuli than the original sample when coated but both returned significantly better results than the uncoated samples.

In both versions the response to Temperature of Ignition was well within the temperature range expected and the Electrostatic Spark Discharge (ESD) and VTS tests gave results similar to those obtained for the RDX standard.

2.3 Assessment in PBXN-109 Formulations

To assess the relative effects of CXM-7/M1 on a range of properties including explosive performance, a comparison was made between the standard PBXN-109 containing CXM-7 and the equivalent formulation (designated PBXN-109/M1) incorporating CXM-7/M1.

2.3.1 Viscosity

It was noted that during the processing of PBXN-109 formulations using CXM-7/M1 the curing rate appeared faster than for formulations using CXM-7. To investigate this observation a viscosity test was conducted on both grades of CXM-7 incorporated in a modified PBXN-109. As the original PBXN-109 formulation was too viscous to be evaluated satisfactorily with the Haake VT 550 Viscotester a similar PBX was formulated in which the binder level was increased to 18%. The formulation contained the same ratio of binder ingredients as used in PBXN-109 although the binder to RDX ratio was increased as shown in Table 5.

Table 5. Modified PBX Formulation

Ingredient	Weight %
HTPB (R45HT)	8.18
DOA	5.59
AO 2246	0.11
Dantocol DHE	0.29
IPDI	1.035
Total Binder (inc. DOA in CXM-7)	**18.00**
Aluminium (Comalco CAP45A)	20.00
CXM-7 or CXM-7/M1	64.79
Triphenyl Bismuth	0.023

The viscosities were measured at 60°C using a Haake Viscotester VT550 with a SVIIP cup and rotor.

The binder (18% HTPB/DOA/AO2246/Dantocol DHE) was prepared as a master batch and used in both mixes. The triphenyl bismuth cure catalyst was not added to the binder master batch but was added as a separate ingredient at the commencement of each mixing process. The assumption was made that the amount of DOA used to desensitise the RDX was the same for both batches of CXM-7 (4.5%). The curing agent, IPDI was added as the last ingredient. Both formulations were subjected to identical mix cycles (time, mixer speed, temp., vacuum).

The tests showed that there was a significant increase in the curing rate of the PBX made with CXM-7/M1 as can be seen from the viscosity versus time curve, Figure 5. It is also evident that the PBX prepared with the CXM-7/M1 has a lower end-of-mix viscosity but because of the faster cure rate its viscosity soon exceeds that for CXM-7.

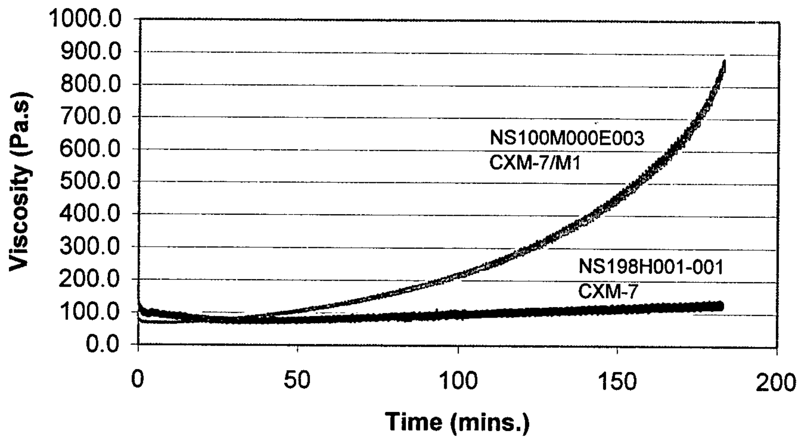

Figure 5. Effect of CXM-7 on Viscosity Results

2.3.2 Mechanical Properties

Uniaxial tensile testing was conducted on the cured PBX samples using an Instron 5500R1185 Universal Test Instrument. The load was applied at a constant strain rate of 50 mm/min to the JANNAF [10] stamped test specimens until rupture.

Table 6 contains the tensile strength data for three batches of PBX for each the two grades of CXM-7 under investigation. It shows that there is a significant change in the strain at maximum load with a consequent change in the Young's modulus for the two formulations. EG205 contains a sample of CXM-7 which had the plasticiser coating removed prior to processing. The correct total amount of plasticiser was added to the mix to obtain a PBX of exactly known ingredient levels. The data shows that there is virtually no difference in mechanical properties between the three PBXN-109 batches and these are considered to be within batch-to-batch variation.

Since the two PBX formulations are identical, except for the CXM-7 used, the differences in mechanical properties are probably due to differences in binder/RDX interaction. It is known that CXM-7/M1 contains an acidic impurity (see Section 2.3.4) and it is thought that this may affect the binder/RDX interfacial bond strength. A comparison of the load versus displacement curves (Figure 6) shows PBXN-109/M1 deviates from the linear (elastic) region at a much lower load than PBXN-109 which is indicative of a lower RDX/binder bond strength.

Table 6. Uniaxial Tensile Test Data

Formulation	Batch	Stress at Max Load (MPa)	% Strain at Max. Load	Young's Modulus (MPa)
PBXN-109	EG119	0.65	13.9	8.31
PBXN-109	EG144	0.61	10.7	8.67
PBXN-109[1]	EG205	0.70	11.3	9.48
PBXN-109/M1	EG174	0.48	28.4	2.83
PBXN-109/M1	EG175	0.48	37.7	2.14
PBXN-109/M1	EG219	0.41	30.6	2.98

[1.] dry RDX (CXM-7 with DOA removed) was used for this batch

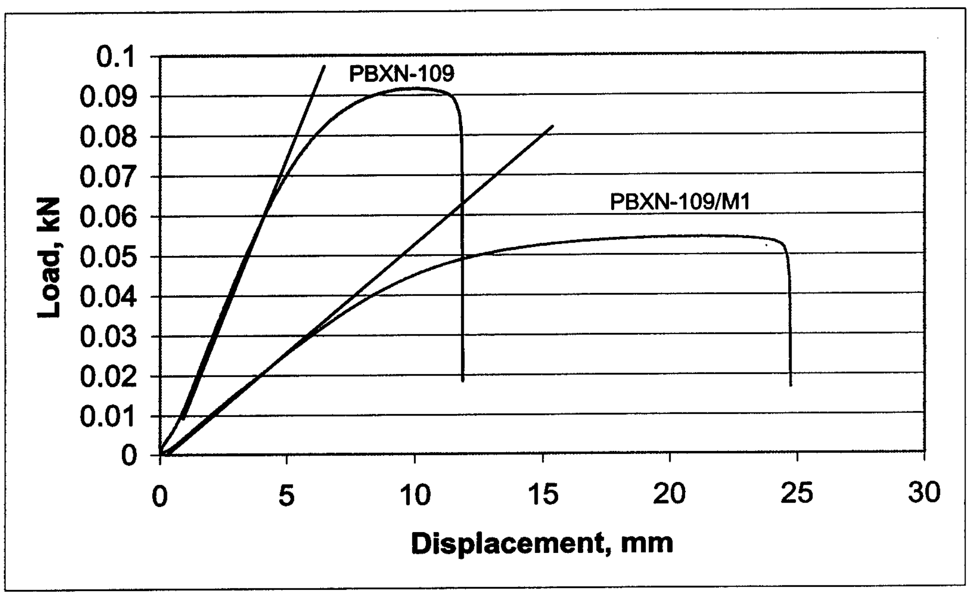

Figure 6. Comparisons of Typical Mechanical Properties for PBXN-109 and PBXN-109/M1

The large difference in strain properties may be a consequence of the poor bond strength and the rounded particles in PBXN-109/M1. The reinforcing effect of the RDX in PBXN-109/M1 is not as strong as in PBXN-109, hence the lower Young's modulus, and as the particles debond the load must be increasingly borne by the binder. However, because of the rounded shape of the particles there is a lower density of

stress concentration sites and the binder is more likely to undergo greater extension before a tear propagates through the material resulting in rupture.

2.3.3 Hazard Assessment and Vacuum Thermal Stability

A summary of the hazard assessment and vacuum thermal stability testing for the two PBXN-109 formulations is given in Table 11. Rotter Impact test evolved gas volumes (mL) are shown in parentheses. Ranges are shown due to variations in batch responses. The minor differences between the two PBX formulations were considered insignificant.

Table 7. Hazard Response Data for the two CXM-7 Formulations

	PBXN-109	PBXN-109/M1
F of I	140-180 (3.3)	160 (3.8)
BAM Friction (N)	252 - >360	324
T of I (°C)	221	216
ESD (J)	No ignition at 4.5	Ignition at 4.5 but not at 0.45
VTS (mL/g)	0.03	0.05

2.3.4 Shock Sensitivity

The shock sensitivity of the two formulations was determined using the MRL Large Scale Gap Test (LSGT) [6]. The results are recorded in Table 8 and show that there was no discernable difference in response to shock stimulus between the two PBXN-109 formulations.

Table 8. LSGT Data

50% point	PBXN-109	PBXN-109/M1
Number of Cards	196	196
Pressure (GPa)	2.35	2.35

2.3.5 Detonation Parameters

2.3.5.1 Velocity of Detonation

The velocity of detonation (VoD) for unconfined charges was determined at two diameters (50 and 82 mm) by either high-speed digital streak photography or time-of-arrival piezoelectric pins spaced at 20.0 mm intervals along the length of the charge.

Table 9. Velocity of Detonation Data

Formulation	Diameter (mm)	Technique	VoD (m/s)
PBXN-109	50	Digital streak imaging	7678
PBXN-109	82	Piezoelectric pins	7617
PBXN-109/M1	50	Piezoelectric pins	7553
PBXN-109/M1	82	Piezoelectric pins	7597

Due to problems with the calibration software for the digital camera the velocity of detonation results for PBXN-109 measured with this technique are not considered accurate: note the result for the 50 mm diameter charge, which is unrealistically high. The more accurate results for comparison are those obtained with piezoelectric pins at 82mm charge diameter. The VoD for PBXN-109 and PBXN-109/M1 are identical (within the limitations of the technique) and comparable to literature values of 7602 and 7630 m/s [7].

2.3.5.2 *Detonation Pressure*

The detonation pressure (P_{CJ}) was estimated from dent tests [8, 9] by comparing with the known output of unconfined charges of TNT and Composition B of the same diameter. Three cylindrical charges of each PBX formulation and melt-cast explosive were fired against mild steel witness plates and the average dent depths for the PBXs are shown in Table 10. These were compared with the dents formed by the standard explosive charges and the calculated relative P_{CJ} are presented in the same table.

Table 10. Relative Detonation Pressure

Formulation	Diameter	Dent Depth (mm)	P_{CJ} relative to	
			TNT (GPa)	Comp B (GPa)
PBXN-109	50	7.78	20.1	19.4
PBXN-109	82	14.28		18.3
PBXN-109/M1	50	8.22	21.3	20.5
PBXN-109/M1	82	14.07		18.1

The literature [7] cites the P_{CJ} = 23.7 GPa for PBXN-109 having a density of 1.681 g/cm^3. The differences between the pressures in Table 10 are not considered to be significant and are slightly lower than the literature value, probably due to the technique used being a comparative method.

2.4 Correspondence with DYNO

The unusual odour and, more particularly, the accelerated binder cure reaction rate was of concern and raised suspicions that the CXM-7/M1 material may have been

contaminated. To clarify the issue contact was made with Dyno Nobel outlining our concerns and providing them with a copy of the viscosity data.

Dyno Nobel's R&D Manager, Mr Oyvind Hammer Johansen, responded with an email [11] in which he addressed our queries and observations. To assess the effect of a particular batch of RDX on PBX viscosity Dyno prepares a formulation in which the curing agent has been omitted and determines the viscosity of this non-reacting system. The absence of the isocyanate curative precludes obtaining information concerning binder cure reaction rate. Thus, there was no possibility of Dyno detecting an unusually rapid cure reaction for a PBX manufactured using the batch of CXM-7/M1 received by DSTO. However, after receiving the query from DSTO Dyno sent samples of CXM-7 and CXM-7/M1 to the Norwegian Defence Research Establishment (FFI) to be evaluated in a PBXN-109 formulation. FFI's results confirmed the trend observed at DSTO. Dyno also acknowledged that they too could readily detect the unusual odour in the batch of CXM-7/M1 sent to DSTO.

After further investigation Dyno found that the sample contained adipic acid [12]. This suggests the CXM-7/M1 was contaminated with an acidic species during production that has subsequently hydrolysed the DOA to adipic acid and ethyl-hexyl alcohol. Dyno believes that the contaminant was introduced from improper cleaning practices in the pilot plant used to produce the CXM-7/M1.

When queried about the unusually high amount of HMX present in the RDX Dyno stated [13] that ADI had requested that the CXM-7/M1 must comply with MIL-E-82886(OS) which states that the RDX must be Type II, that is at least 4% HMX must be present. Dyno then added 5% HMX to the RDX Class 1 in accordance with ADI's request. Analysis by Dyno gave an HMX content after addition to be 4.7%, which is in agreement with that found for the analysis conducted here. This material was then mixed with the RDX Class 5 to make the CXM-7/M1, which was delivered to ADI.

3. Conclusions

1. The CXM-7/M1 as supplied to ADI and evaluated by DSTO is unsuitable for use in the manufacture of PBXN-109 as the explosive fill for the Penguin ASM warhead, due to the presence of a contaminant.
2. Dyno Nobel is aware of the contamination problem, has identified its source and has taken actions to ensure a quality product in the future.
3. The RDX in CXM-7/M1 does not strictly conform to MIL-E-82886(OS) as the HMX content is an addition rather than a processing by-product.
4. The sensitivity properties of the CXM-7/M1, and the PBXN-109 made from it, are similar to the original materials.
5. The explosive properties of PBXN-109/M1 are indistinguishable from the original material.

6. The recrystallisation process used in the manufacture of the RDX for CXM-7/M1 has produced particles at are more rounded and hence of benefit in lowering the viscosity of the PBX slurry.
7. The use of CXM-7/M1 in PBXN-109 would lower the end-of-mix viscosity of the slurry, improve the flow properties and potentially reduce the possibility of incurring casting defects in the Penguin warhead fill.
8. While changing grades of CXM-7 for the production of Penguin warheads may not be an option it would be worthy of consideration for any future ventures involving PBXN-109 or other PBX formulations compatible with the use of CXM-7.

4. Acknowledgements

The authors are grateful to John Symes, Danielle Gilboy, Max Joyner and Bob Arbon for their contribution to the manufacture and/or testing of the explosive materials dealt with in this report. Thanks is also extended to Dave Harris, George Katselis, Carmine Caputo and Rachel Campbell for firings and instrumentation support during explosive performance testing and to John Carley (Proof & Experimental Establishment, Port Wakefield) for his role as Firing Officer during LSGT trials.

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19. ABSTRACT
An evaluation of a new grade of CXM-7, the explosive component of PBXN-109, was conducted at DSTO as R & D support to ADI Ltd, the sub-contractor for the manufacture of the Penguin ASM warhead. Tests were performed to characterise the material's physico-chemical and sensitiveness properties. The processing properties of PBXN-109 incorporating this grade of CXM-7 were also evaluated and the explosive performance properties were determined. Testing showed the new CXM-7 to be contaminated with an unknown material which adversely affected its processing properties. However, it was noted that the new material had a particle morphology more suited to processing than the original CXM-7. The explosive properties of PBXN-109 containing the new CXM-7 were equivalent to the current material. If the new material can be obtained free from contaminants it does offer some advantages, in terms of processing and quality of the explosive fill, over the original CXM-7.

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